

TABLE 5.—*Determinations of the dust content of the atmosphere during balloon flights*

FREE-BALLOON DETERMINATIONS					
Date	Time	Location	Height above ground	Dust content, particles per c.c.	Remarks
1924 Apr. 1	4:45 p. m.	Scott Field.....	Feet 0	798	Large particles like spores.
	5:35 p. m.	Near Scott Field.....	1,050	(¹)	
	6:25 p. m.	.....	1,900	101
	6:52 p. m.	Over Nashville, Ill.....	3,000	38	
	8:00 p. m.	Over Mt. Vernon, Ill.....	4,000	28	
	8:50 p. m.	Over Wayne City, Ill.....	5,100	(¹)	
	9:06 p. m.	Over Mill Shoals, Ill.....	5,950	16	
	9:39 p. m.	.....	7,000	9
	12:30 p. m.	Over Augusta, Ga.....	6,800	16	
	1:30 p. m.	.....	6,000	(¹)
	1:50 p. m.	.....	5,000	19
	2:25 p. m.	Waltersboro, S. C.....	4,000	22	
11 12	3:45 p. m.	Near St. Jacob, Ill.....	2,600	36	Cover glass broken.
	7:00 a. m.	Near Wasepi, Mich.....	2,000	41	
	9:05 a. m.	Over Jackson, Mich.....	4,000	59	
	11:10 a. m.	4 miles W. Detroit.....	3,500	57	
	11:40 a. m.	Over Detroit, Mich.....	1,000	152	
	12:35 p. m.	Over St. Claire Lake.....	4,100	23	
	7:50 p. m.	4 miles NNE. Mascoutah, Ill.....	1,300	69	
	8:05 p. m.	.....	2,500	24
	8:35 p. m.	.....	3,700	13
	9:15 p. m.	SW. Mt. Vernon, Ill.....	4,800	58	
	23 6:10 p. m.	E. Wanda, Ill.....	1,500	76	
	24 6:40 a. m.	Over Lake Michigan.....	1,500	71	
29 May 7	1:45 p. m.	3 miles SE. Black Creek.....	1,800	55	Cover glass broken.
	3:20 p. m.	2 miles NNE. Lebanon, Ill.....	3,000	44	
	3:40 p. m.	4 miles SSE. Troy, Ill.....	4,100	40	
	5:14 p. m.	4 miles SE. Scott Field.....	2,200	69	
	5:25 p. m.	1 mile S. Mascoutah, Ill.....	3,000	48	
	5:52 p. m.	Above clouds.....	4,300	16	
	6:14 p. m.	Above clouds.....	5,200	.....
	6:40 p. m.	Above clouds.....	6,200	12	
	7:00 p. m.	Above clouds.....	6,800	(²)	

DIRIGIBLE DETERMINATIONS

Apr. 28	10:00 a. m.	1 mile W. Scott Field.....	600	35	to
		2 miles NE. Belleville, Ill.....	550	95	
		2 miles W. Belleville, Ill.....	550	72	
		1 mile S. Country Club.....	600	117	
		5 miles W. East St. Louis.....	600	108	
		5 miles W. Free Bridge.....	500	60	
		2 miles W. Free Bridge.....	500	44	
	11:00 a. m.	3 miles W. Belleville.....	500	38	
	11:45 a. m.	2 miles W. hangar.....	400	76	
	Noon	1 mile SW. hangar.....	300	98	

SCOTT FIELD DETERMINATIONS

Mar. 31	3:45 p. m.	Scott Field.....	0	522	White sky.
Apr. 7	2:00 p. m.	Scott Field.....	0	142	
8	10:00 a. m.	Scott Field.....	0	303	
9	9:30 a. m.	Scott Field.....	0	112	
10	11:30 a. m.	Scott Field.....	0	192	

¹ No visible record.² Less than 10.

HIGH MAXIMUM TEMPERATURES IN LATE SPRING OF 1925

By ALFRED J. HENRY

Following the warm winter of 1924-25, especially the month of February, it would not be surprising had there been more or less frequent short periods of unseasonably low temperature and blustery weather in the spring. In Europe such periods did occur, but here in the United States March as a whole was warm. April also was warm and especially characterized by a two-day period of abnormally high temperature when the daily maximum rose to 93° and 94° respectively. The average maximum temperature for April in Washington, D. C., is 63°. Residents of the United States east of the Rocky Mountains, and more especially those who live in Atlantic seaboard States, may recall that once every so often an outburst of summer heat is experienced sometimes as early as April. The April maximum temperature in Washington, D. C., has equaled or exceeded 90° in 5 out of the last 55 years, or 1 year in 11. For May with a mean maximum of 75° the maximum temperature has equaled or exceeded 95° in 6 out of the last 55 years and the highest maximum in that period, 97°, was recorded on May 23 of the present year.

Table 5 gives the time, place, and height above ground at which dust determinations were made. Table 6 summarizes the results.

TABLE 6.—*Summary of atmospheric dust determinations from balloons*

Height in feet	Number of determinations	Dust particles per c.c.			Remarks
		Mean	Max.	Min.	
Between 5,950 and 7,000.....	5	13	16	9	Free balloon.
Between 3,700 and 5,000.....	9	29	59	13	Do.
Between 2,000 and 3,500.....	8	45	69	24	Do.
Between 1,300 and 1,900.....	5	74	101	55	Do.
1,000.....	1	152	.....	.....	Free balloon over Detroit.
Between 300 and 600.....	10	74	117	35	Dirigible balloon.
Surface.....	6	345	798	112	At Scott Field.

These determinations show considerably less dust in the atmosphere than was found by Mr. Hand during airplane flights. This is partly explained by the fact that the balloon flights were made in the spring when we would expect less dust in the atmosphere than late in the season after convection has been adding to the dust at high levels for a long period. Further, it was suspected that some of the dust found during airplane flights came from the engine exhaust. We must therefore conclude that in the open country under normal conditions the dust content of the atmosphere is small above an altitude of 2,000 feet from the surface.

On April 12 the influence of smoke from the city of Detroit is apparent at elevations up to 3,500 feet.

CHARACTER OF THE DUST PARTICLES

Finely divided mineral matter, probably dust taken up from the surface of the ground by the wind, predominates in summer, with occasionally a few spores. These latter were observed at intervals from July 12 to November 21, in 1924, the maximum number being 20 per 1,000 cubic centimeters on August 29. In 1925 they were first observed on June 8. During the winter and especially on mornings with little wind, or with wind from an easterly direction, products of combustion may predominate. These latter are usually larger than surface dust particles.

These outbursts are considered as an integral part of the climate of the eastern two-thirds of the United States. They result from an apparently fortuitous combination of at least three basic initial conditions, as follows:

(1) The presence of an anticyclone over the eastern seaboard of the United States, with little or no movement except a slow settling to the southward.

(2) The presence of a cyclone west of the Mississippi, with a slow movement toward the east-northeast.

(3) Small net loss of heat from the earth's surface due to the presence of haze or light cirrus clouds.

When on any day in spring the two items first named are in combination the conditions are ideal for a rapid surface warming over the great interior valleys of the United States. The winds on the west margin of the anticyclone will be southerly, and although they may not necessarily be warm in the beginning they will soon become so. The change to higher temperature is not, as might be expected, uniform and coterminous with the area of the southerly winds, but rather it is localized in certain areas which appear to have a rather definite relation to

the center of the western cyclone; thus with a cyclone centered over Montana the area of high temperature will be found to the east or southeast, and this latter has a definite progression toward the east. The fact that these regions of high temperature begin in the west and progress to the east in harmony with the movement of cyclones appears to be conclusive evidence of their terrestrial origin.

Atmospheric temperatures depend on the balance between incoming solar radiation and outgoing radiation both from the air itself and the earth; hence in any discussion of temperature changes account should be taken of the sky conditions, especially with respect to outgoing radiation.

The changes of temperature here considered are the simple differences between the successive 8 a. m. (75th meridian time) observed temperatures with the appropriate algebraic sign prefixed.

Paradoxical as it may seem, outgoing radiation under one set of conditions will tend to depress the temperature and under a different set of conditions will tend to elevate it. It is with the latter that we are here chiefly concerned. As a result of impeded outgoing radiation on any night the nocturnal minimum will not be so low as with radiation to a clear sky. The amount of the elevation of the minimum is of course proportional to the amount of decrease in the outgoing radiation, but it may and does amount to as much as 10° F. When the night minimum is elevated by that amount the daily upward march of temperature starts at a higher level than otherwise would be the case and the maximum is of course higher.

On the morning of April 23, 1925, the minimum temperature at Washington, D. C., was 53°. The afternoon maximum on that date was 93° or a rise of 40° from the night minimum of the preceding 24 hours. On the next day the minimum was 62°, and this was followed by a maximum of 94°, or a range of 32° as against 40° on the preceding day. A search into the cause of the high maximum of the 23d will now be made.

On April 23 there were heavy clouds until 10 a. m., light clouds until 2 p. m., a sprinkle of rain from 7:20 to 7:30 and again from 8:45 to 8:50 a. m. The relative humidity was moderately high and the winds were from the south and southwest most of the day. A measurement of solar radiation made at Washington at noon on April 24 gave only 70 per cent of clear sky intensity. On this day, it may be remembered, the range in temperature was not so great as on the preceding day.

I therefore conclude that the April hot spell was due to the prevalence of southerly winds at a time when outgoing as well as incoming radiation was less than usual. This hot spell was brought to a close on the 24th by rain and a shift of the wind to easterly.

The high temperatures of May 21-24 were originally due to the prevalence of southerly winds over the great interior valleys from the 20th to the 23d. These winds were induced by a cyclone which moved from Alberta to the mouth of the St. Lawrence during the four days, May 18-21.

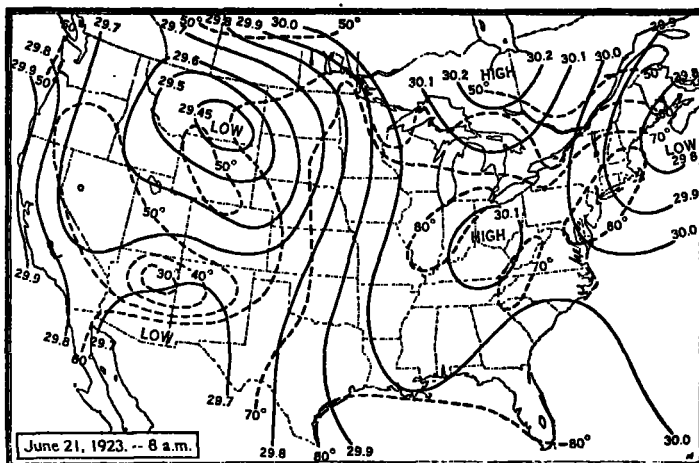
This cyclone was not followed by colder weather in its rear for reasons that are unknown. Possibly due to the fact that large masses of warm air persisted in its rear, it was followed almost immediately by a fresh cyclone which appeared on the Weather Bureau maps of the 22d over North Dakota, moved to the Lake Region by the morning of the 23d and was thence displaced to the southeast and eventually over the Atlantic by a strong anticyclone that first appeared on the map of the 23d.

This cyclonic disturbance was remarkable in several respects; its form was that of a long narrow oval that stretched west-northwestward from western Lake Erie to Minnesota with lowest pressure, 29.46 inches, in that State. It might easily be considered as an east-west trough of low pressure banked on its north by cold air and on its south side by extraordinarily warm air for the season. Thus at Canton in northern New York the 8 a. m. temperature on May 23 was 32° while at Binghamton in the southern part, only about 160 miles distant, the temperature at the same moment was 78° and this great contrast in temperature extended westward into the Upper Great Lakes region.

Such a temperature distribution is of course unstable. The colder northern air naturally gravitated southward and as a result the trough of low pressure was displaced to the southeast as previously stated. Equilibrium of temperature on the two sides of the disturbance was restored during the ensuing 24-36 hours, and this was accomplished without the occurrence of extraordinary climatic phenomena, if we except the very severe hailstorm at Baltimore, Md., as elsewhere described in this REVIEW, p. 261. This storm was undoubtedly due to the great north-south temperature contrasts on May 24, 1925. Doubtless many other hailstorms, of which no notice has come to hand, occurred on the same date.

Snow fell in the upper Great Lakes region, and the hot spell in the East was terminated by rains on May 24.

In conclusion I may point out that while the general type of pressure distribution that brings about large abnormalities in temperature already has been indicated (items 1 and 2), yet it is the small day-to-day pressure variations superposed upon the more or less stable formation (the western extension of the Azores HIGH over the southeastern States is meant) which in the final analysis are the immediate and direct cause of large departures from normal temperature. As illustrating one of the many modifications of the general type, I present herewith a reduced copy of the weather chart for June 21, 1923, a day on which the maximum temperature in Washington, D. C., was 98°, Baltimore and Philadelphia, 100° each, New York, 94°, Boston, 96°, and Atlantic City, 90°.



Modifications of the general type are chiefly brought about by the movement of cyclonic systems eastward down the St. Lawrence Valley. Many of these systems already have reached the dying stage, and therefore have but little influence upon the general pressure distribution, but occasionally a vigorous cyclone comes along, or more specifically a moderate cyclone develops much intensity as it approaches the eastern seaboard. It is not known

why this increase in intensity should take place. The forecaster must of necessity await until the development has actually taken place before he can utilize the information thereby afforded. I mention this fact because of its bearing on long-range forecasting, a subject which at present is very much in the forefront.

The weather chart here presented differs only in detail from the ordinary hot weather type for early summer. On this chart the extreme western projection of the western North Atlantic anticyclone has been detached from the main oceanic area by a fall in pressure incident to the eastward movement of the cyclone that is centered off the Maine coast. As a result of this separation the inland HIGH over the upper Ohio Valley has set up an independent wind circulation—north to east winds on its right margin and southerly winds on its left margin. This circulation, however, had no effect on the general level of the temperature within its sphere of influence. The temperature at the time the chart was made happened to be close to the eighties from the middle Mississippi Valley eastward to the Atlantic. An illustration of a sharp rise in temperature with north and northwest winds may be found in the region on the east border of the HIGH. At Washington, D. C., temperature rose from 81° at 8 a. m. to 97° at 5 p. m., with continuous light north and northwest winds.

Inspection of the chart will show that the temperature was above 70° over practically the whole area east of the 100th meridian and south of the 45th parallel. The hot weather that had set in on June 18 continued until the 28th, and it was brought to a close by a cyclonic disturbance that developed over Nevada on the 23d, increased greatly in intensity while passing down the St. Lawrence Valley on the 27th, and thus created a barometric gradient for northerly winds which effectively lowered the temperature in Atlantic seaboard districts. And this is merely another case of the inability of the forecaster to read the daily weather chart beyond a few days in the immediate future.

*The June, 1925, warm spell.*²—The foregoing was written during the prevalence of a period of high maximum temperatures in the Middle Atlantic States that for duration has never been equaled since Weather Bureau observations began 55 years ago. These high maxima were due to a pressure distribution differing in no material particulars from that characteristic of high maxima in late spring as hereinbefore described. The daily extremes of temperature at Washington, D. C., for the days in April, May, and June herein referred to will be found in the table next below.

TABLE 1.—Daily extremes in temperature Washington, D. C., for the days given

Date	Daily extremes		Date	Daily extremes	
	Maximum	Minimum		Maximum	Minimum
1925	° F.	° F.	1925	° F.	° F.
April 23.....	93	62	June 3.....	90	71
April 24.....	94	54	June 4.....	89	73
May 23.....	97	60	June 5.....	100	71
May 24.....	90	48	June 6.....	97	74
June 1.....	94	59	June 7.....	94	73
June 2.....	97	65	June 8.....	93	72

² Nature, London, June 20, 1925, gives a brief account of a warm spell in England, especially in southern and midland districts. The period of high temperatures began June 3 and continued at least until the 11th. One wonders whether the near approach to synchronism in both the United States and England was purely fortuitous.—Ed.

Since the foregoing was written Mr. R. M. Dole, of the Lansing, Mich., station, has contributed a few notes on the hot weather in June, 1923 and 1925, respectively. These notes, pertaining as they do to free air movements, are of very considerable interest and are here reproduced.

In such stagnations [times of westward extension of North Atlantic high over the continent] the upper clouds have been repeatedly observed to be moving very slowly in their normal directions or from abnormal directions. In the June, 1923, heat wave the upper clouds were observed to be moving very slowly from some westerly direction, while in the June, 1925, heat wave the upper clouds were observed on several occasions to be moving from east, southeast, and south very slowly. The 1923 heat wave was accompanied by soaking thunderstorms, while in 1925 there was a drought. It has been observed in other droughts that the upper clouds were moving from some easterly direction.

It was to be expected that free-air observation by balloons would confirm the fact that the air movement aloft was much lighter than the normal, thus contributing to a super heating. Several free-air balloon flights were selected during these heat periods and tabulated. The figures conclusively show that the air movement is light aloft as shown by the slow movement of the upper clouds. The average movement of free air for summer was worked out for Lansing by Mr. C. L. Ray up to the 6,000 m. level and the levels higher are extrapolated. In the six flights it will be noticed that the wind movement tends to become lighter the higher the level, confirming the observations of the slow movement of the upper clouds and the suspected stagnation.

TABLE 2.—Wind movement in meters per second and the levels in meters during hot spells in June, 1923 and 1925, respectively

Year 1925			Levels (meters)	Year 1923			
June 5	June 6	June 7		June 17	June 22	June 23	Normal
Wind movement in m. p. s.				Wind movement in m. p. s.			
13	7	7	500	6	4	1	6
1	5	8	1,000	2	3	3	6
9	7	6	1,500	4	2	6	7
9	4	5	2,000	2	2	7	8
9	8	6	2,500	4	4	6	8
10	12	6	3,000	7	5	4	9
8	6	5	3,500	5	5	6	10
8	9		4,000	5	5	6	10
5	4		4,500	5	3	3	10
	3		5,000	5	2	3	11
	2		5,500	4	6	2	(11)
	2		6,000	5	6	2	12
	2		6,500	6	5	2	(12)
	5		7,000	7	4	2	(13)
	5		7,500	5	4	2	(13)
			8,000	5	4	2	(14)
			8,500		4		(14)
			9,000		4		(15)
			9,500		5		(15)

CLOUD OBSERVATIONS

Cl. w. mod.	Cl. Cu. sc. slow.	Cl. Cu. A. cu. A. s.	Cl. sw. slow.	A. cu. w. slow.	Cl. nw. slow.
		se. slow.			

NOTE.—"Normal" values in parenthesis are estimated by extrapolation.